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Consumer Reaction to Beef Safety Scares[1]

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Abstract

This study examines the impact of two beef safety scares on retail-level meat per capita consumption and prices in Japan. The objective is to investigate the Japanese consumer reactions to the news of FMD and BSE discoveries, as reflected in the quantity and price changes in the immediate neighborhood of each event. Better understanding of consumer reactions to beef safety scares helps the beef industry restore consumer confidence after food safety crises and provides opportunities for national-level product differentiation based on beef quality and traceability.

Keywords: consumer behavior, food safety, beef, Japan.

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Introduction

Food safety scares have short-run and long-run impacts on consumer preferences because of their health and well-being implications. The effects of food safety concerns are part of a dynamic process where consumers often change consumption habits during the scare and later revert to previous buying patterns. Sociological researchers argue that, generally, as a food safety scare receives prominent media coverage, consumers initially over-react by avoiding the identified food item (Mazzocchi, 2005). However, concern gradually diminishes and a new equilibrium is established, though low level anxiety can continue for some time. Any new information that consumers gain during food safety scares can change their behavior when future shocks occur, and as they learn the negative consequences of different safety scares, their reaction to future outbreaks may be heightened. Producers and retailers need to be cognizant of the length and extent of consumer reactions to different food safety scares.

Public awareness of beef safety increased worldwide during the past two decades as a result of highly publicized cases of E. coli food poisoning, foot and mouth disease (FMD) outbreaks and *Bovine Spongiform Encephalopathy* (BSE) scares reported in the EU, US, Canada, Japan, and other regions. Consumer concerns and the public and private costs of beef safety incidents led to increased attention to strategic options for prevention and management of beef safety risks to reassure consumers and address their needs, restore lost markets, and comply with safety regulations.

The Japanese beef industry faced an outbreak of FMD in March of 2000, and a BSE crisis in September of 2001. FMD was reported in cattle in Miyazaki city during March 2000, the first outbreak in Japan since 1908. FMD is a highly contagious disease, so FMD-free countries usually ban imports in many animal and animal products from the infected country when it is detected. Importing countries often have a difficult time in keeping the disease outside their country and from spreading once it enters. Transmission of FMD most commonly occurs during physical or close contact between acutely infected and susceptible animals.

The first case of BSE in Japan was reported on September 10, 2001. BSE is a fatal neurological disease which typically occurs in adult animals aged five years or older. The exact cause of BSE is not known, but it is primary transmitted by feeding of diseased animal products. Consumption of contaminated beef by humans is suspected to cause Creutzfeldt-Jakob disease. BSE discovery in Japan resulted in considerable economic damage to Japanese beef producers as well as food service industries, in part due to the actions of Japanese beef industry and government officials that eroded consumer confidence (McCluskey, et al. 2004). In response to the crisis, the Japanese government launched an aggressive marketing campaign promoting the safety of Japanese beef (Fox and Peterson, 2002).

Heightened visibility appeared to create opportunities for branding, labelling, and product differentiation based on traceability and beef quality. Labelling of credence attributes reduces information costs to consumers and can result in increased demand for quality-assured products. Beef producers and retailers can differentiate their beef products to protect markets, or perhaps earn higher premiums, by using beef safety and quality assurance as a strategic response to consumers' risk perception of beef.

The objective of this study is to investigate the impact of the FMD and BSE events on Japanese retail meat quantities and prices, with emphasis on beef of varying quality and origin. We use a co-integrated vector error correction (VEC) model, directed acyclic graphs, and historical decomposition to investigate Japanese consumer responses to the sudden, unexpected beef safety scares. These dynamic techniques result in a more accurate estimation of the complex interrelated effects among the variables under study than the traditional static demand models. Directed graphs, in particular, allow the errors among the endogenous variables to be incorporated into the forecasted effects of these meat market shocks over time. We trace the dynamic effects of these meat market shocks on retail-level prices and quantities over time to see if these changes are consistent with well-informed rational consumer behaviour.

The Empirical Model and Data

The Data

Fish, poultry, and four beef types identified by type and origin, namely, U.S., Australian, Japanese wagyu, and Japanese dairy beef are evaluated. The sample data for fish and poultry were not distinguished by source of origin. The monthly time-series retail data used by Peterson and Chen (2005) are used in this study[2]. The sample contains 105 observations from April 1994 to December 2002. Retail prices and quantities for beef were obtained from Agriculture and Livestock Industries Corporations (ALIC) data. Beef prices were the weighted prices of four cuts (chuck, loin, round and flank) reported by ALIC based on Nikkei Point-of-Sales.

Retail prices and quantities for fish and poultry were both obtained from the Retail Price Survey by the Statistical Bureau Ministry of Public Management, Home Affairs, Post and Telecommunications. Fish prices used in the study were the weighted average of tuna, horse mackerel, flounder, yellow tail and cuttlefish. The fish types selected are composed of high, medium and low-end fish types. The choice of fish types to include in the study reflects the most representative fish series for which data were available and complete. Table 1 contains the descriptive statistics

[2] We thank Hikaru Peterson for providing the dataset.

of the price and quantity series in levels. These series were transformed into natural logarithmic form for the analysis.

Table 1: Descriptive Statistics of Meat Prices (Yen Per Gram) and Quantities (Per Capita Consumption in Grams) (N=105)

Variables	Mean	Max	Min	Std Dev
US Beef Price	2.56	2.83	2.22	0.15
Aus. Beef Price	1.90	2.11	1.67	0.11
Wagyu Price	5.59	6.00	4.99	0.23
Dairy Price	3.58	3.86	3.15	0.16
Fish Price	2.40	2.73	2.03	0.19
Poultry Price	0.93	1.01	0.68	0.04
US Quantity	50.95	80.12	7.39	13.08
Aus. Quantity	36.34	96.46	14.10	20.48
Wagyu Quantity	58.80	140.77	7.83	34.00
Dairy Quantity	113.97	170.99	26.43	28.22
Fish Quantity	349.60	572.33	278.65	40.60
Poultry Quantity	300.09	424.00	241.00	36.43

The Empirical Model

The impact of food safety scares has been extensively investigated in the literature. The results of these studies generally show that food safety scares affect prices and demand adversely, and that consumers may be willing to pay higher premiums for safety and quality assurance. (e.g., Marsh, Schroeder and Mintert, 2004; Piggott and Marsh, 2004; McCluskey, et al., 2004; Peterson and Chen, 2005; Livanis and Moss, 2005; and Chopra and Bessler, 2005).

Scientific methods applied to food safety events have a wide range from most commonly used models of Almost Ideal Demand System, the Rotterdam models and their different variations, to models of contingent valuation, experimental auction and conjoint analysis. These models, however, are not quite appropriate to investigate the short-run dynamic consumer reactions to sudden beef safety events in the neighborhood of each event as reflected in the actual retail-level changes, which is the main objective of this research. The methodological approach used in this study includes Johansen's co-integration tests along with a VEC model, directed acyclic graphs, and historical decomposition to investigate the dynamics of price and quantity changes. The multivariate VEC models used in this research treat the price and quantity series as two separate systems where each system has six endogenous variables for the fish, poultry, and beef types.

The VEC model will not only allow estimates of short-run relationships for the price and quantity series, but it also preserves the long-run relationships among the variables. VAR/VEC models have the advantage of describing the reaction to scares

dynamically. Co-integration binds the series into a long-run relationship; it is now commonplace to examine time-series variables by co-integration techniques. Historical decomposition aids in providing a visual explanation of the impact of the beef safety shock on the price and quantity series in the neighborhood of each event. Specifically, orthogonal innovations are constructed using graph theory to determine causal patterns behind the correlation in contemporaneous innovations of the VEC model.
The first step is to test if the series are stationary by using the Augmented Dickey-Fuller (ADF) test. The test involves running a regression of the first difference of the series against the series lagged one period, lag difference terms, and a constant as follows:

$$\Delta Z_t = \alpha_0 + \alpha_1 Z_{t-1} + \sum_{j=1}^{n} \beta_j \Delta Z_{t-1} + \varepsilon_t$$

where ΔZ_t is the first difference of the time series. The stationarity test is the same as checking the series for unit roots to see if they are random walk, that is, their mean and variance are not constant over time. The null hypothesis is that the series are non-stationary. The non-stationary series are integrated of order one or I(1) with the first differences being stationary or I(0). ADF test can under-reject when sudden shocks are the cause of structure breaks in series with deterministic trends, and prior to ADF, test for structure breaks in the series are recommended (Sanjuan and Dawson, 2003).

Johansen's co-integration test is performed to determine whether the series are co-integrated and the co-integrating rank, r, using the likelihood ratio (Holden and Perman, 1994). If the series are integrated and co-integrated, then a VEC Model is appropriate to characterize the multivariate relationships among the variables in the series (Engle and Granger, 1987; Enders, 1995). The VEC model uses both short-term dynamics as well as long-term information; it has a co-integrating equation which captures the long-run relationship among the variables due to the presence of co-integration.

The specification of the VEC model for each six equation system is:

$$\Delta X_t = \alpha_0 + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \prod X_{t-k} + \varepsilon_t$$

where ΔX_t is a (6x1) matrix (ΔX_{1t}, ΔX_{2t} and ΔX_{6t} represent the six variables in the series); α_0 is a (6x1) vector of intercept terms; the $\Gamma_i \Delta X_{t-1}$ terms reflect the short-run relationships among elements of the X_t matrix, and the $\prod$ matrix captures the long-run relationship among the variables. The $\prod$ matrix can be decomposed into two p x r matrices, α and β, where $\prod = \alpha\beta'$. The matrix β contains the co-integrating vectors that represent the underlying long-run relationship and the α matrix describes the speed of adjustment at which each variable moves back to its long run equilibrium (Johansen and Juselius, 1992; Schmidt, 2000).

The covariance matrix of the VEC model is used to investigate the causal relationship among the variables using directed acyclic graphs (Bessler and Akleman, 1998; Saghaian et al., 2002). With this method, an algorithm is utilized which begins with an undirected graph where all the variables are originally connected. The program removes adjacent edges when partial correlations are not statistically significant at an identified significant level, and assigns causal flow directions for the remaining edges based on the partial correlations of the residuals (Spirtes, Glymour, and Scheine, 2000). Non-zero, off-diagonal elements of the residual matrix allow for a shock in one variable to affect other variables in the model contemporaneously, which determines the causal structure behind the correlation in innovations (Swanson and Granger, 1997).

Finally, historical decompositions break down the price/quantity series into historical shocks in each series to determine their responses in a neighborhood (time interval) of the FMD and BSE events. Historical decomposition graphs are based upon partitioning of the moving average series into two parts:

$$Y_{t+j} = \sum_{s=0}^{j-1} \psi_s U_{t+j-s} + \left[W_{t+j}\beta + \sum_{s=j}^{\infty} \psi_s U_{t+j-s} \right]$$

where Y_{t+j} is the multivariate stochastic process, U is its multivariate noise process, and W is the deterministic part of Y_{t+j} (RATS, 2004). The first sum represents that part of Y_{t+j} due to innovations (shocks) that drive the joint behaviour of the series for periods $t+1$ to $t+j$, the horizon of interest, and the second is the series forecast based on information available at time t, the date of an event –that is, how endogenous variables would have evolved if there had been no shocks.

Chopra and Bessler (2005) who used a similar method to investigate the short-run and long-run impacts of FMD and BSE on meat prices in the United Kingdom showed that price responses in the neighborhood of FMD and BSE events were dissimilar, and consistent with well-informed, rational consumers. Finding comparable results in the Japanese market would suggest that economic theory allows generalizable predictions about price responses to future food safety scares, even across diverse cultures. This study further investigates the quantity responses and will determine whether and how the shocks also affect the amount of various meat consumed.

The Results

The results of the unit-root test are estimated by OLS and presented in Table 2. The second column of the table shows that the null hypothesis of zero first-order autocorrelation cannot be rejected at the 5% level of significance using the Durbin-Watson bounds test for each series except fish price, poultry price, US quantity, and dairy quantity, given the MacKinnon critical value. The right-most column of Table 2 gives the results of the ADF test for the first difference transformation of the series. The null hypothesis is rejected for all variables after first differencing.

Table 2: Augmented Dickey-Fuller (ADF)a Test Results.

Variable	Test Results for Variables in Levels	Test Results for Variables after First-Differencing
US Beef Price	2.64	9.47**
AUS Beef Price	2.39	11.60**
Wagyu Beef Price	2.13	11.11**
Dairy Beef Price	1.64	13.05**
Fish Price	3.02*	7.45**
Poultry Price	4.01**	9.40**
US Beef Quantity	3.40*	10.09**
AUS Beef Quantity	0.90	12.37**
Wagyu Beef Quantity	1.40	11.48**
Dairy Beef Quantity	2.76*	12.86**
Fish Quantity	2.30	4.44**
Poultry Quantity	1.98	4.14**

Note: ** 1% significance level, * 5% significance level.
[a] Test statistics are in absolute value and compared to MacKinnon (1996) one-sided p-value.

Table 3 presents the results of co-integration tests for the price and quantity series. As indicated by these results, the null hypothesis that $r = 0$, $r \leq 1$, and $r \leq 2$ is rejected at the 5% level for the price series, but the null hypothesis cannot be rejected at the 5% level that the co-integrating rank of the price system is at most 3. For quantity, the null hypothesis that $r = 0$ and $r \leq 1$ is rejected at the 5% level, but the null cannot be rejected that the co-integrating rank of the quantity system is

Table 3: Johansen Co-integration Test Results for Prices

Null Hypothesis[a]	Trace Statistics	5% Critical Value	Eignenvale
$r = 0$ *	185.46	95.75	0.53
$r \leq 1$*	109.64	69.82	0.41
$r \leq 2$*	56.34	47.86	0.26
$r \leq 3$	25.44	29.80	0.15
Johansen Co-integration Test Results for Quantities			
$r = 0$ *	170.37	95.75	0.61
$r \leq 1$*	75.10	69.82	0.27
$r \leq 2$	43.86	47.86	0.19

[a] r is the co-integrating rank, MacKinnon-Haug-Michelis (1999) p-value. * 5% significance level.

less than 2. Thus there are long-term relationships among the variables and the VEC model is appropriate in order to determine the directed graphs and causal patterns for prices and quantities.

The residual correlation matrix of the estimated VEC models provides the contemporaneous innovations (errors) that show how errors among the endogenous variables are related. Considering the correlations among these errors allows better estimation of the pattern for the endogenous variables. The results (not shown, available from the authors upon request) show that the strongest correlation exists between the Japanese wagyu and dairy prices (0.68). This makes sense as pricing policies for Japan's beef industry are mutually applied to wagyu and dairy beef. These results also show that residuals associated with the two import origins are slightly correlated with dairy, but U.S. residuals are more strongly correlated to residuals from Japanese wagyu beef than Australian. Finally, there is little correlation in residuals for U.S. and Australian beef prices or among fish, chicken, and beef prices. There is much more correlation among the residuals from the quantity model. Correlations between US and wagyu, US and dairy, and wagyu and dairy are all high among the beef quantities. Fish and poultry consumption residuals are also highly correlated. Most correlation coefficients among the quantity errors are 0.40 or above, much higher than for prices.

Any inference on responses of beef prices and quantities to safety scares requires a careful investigation of contemporaneous correlation among corresponding innovations. In a case where contemporaneous correlation among the errors is present, historical decomposition functions may be distorted because of the effects of innovations in another variable in the system at the same time. Incorporating the complex interplay among these prices and quantities is required for the best projections to be forthcoming. Piggott and Marsh (2004), using U.S. quarterly data, showed that the effects of food safety concerns were only contemporaneous. A formal test of contemporaneous causal structures is performed here, where innovations are orthogonalized to obtain the historical decomposition functions. The TETRAD IV software is applied to the correlation matrix to generate the causal patterns and structure of the price and quantity series on innovations from the endogenous variables in each system (Spirtes et al., 1999). [3]

The historical decomposition results for the endogenous variables from the FMD and BSE shocks are shown over a 12 month horizon. The dynamic impacts of the shocks can spread over many months or dissipate quickly. We don't look at endogenous variables very far into the future because we are interested in the shortrun; it is likely that other effects that normally occur after a few months would cloud their impacts[4] .

[3] The directed acyclic graphs of causal structures are not shown; they are available from the authors upon request.

[4] There are 24 separate historical decomposition graphs for the price and quantity series. Only the BSE graphs for the quantity series are presented here; the rest are available from the authors. For a more detailed price analysis see Saghaian, et al., 2007.

The FMD Impact

The FMD historical decomposition shows a negative price impact, especially on the two prices of domestically produced beef, wagyu and dairy, and on imported Australian beef. Since FMD was discovered in live domestic cattle and with 92% of the live cattle imports in 2000 coming from Australia, Japanese consumer reaction is reflected by a sudden fall in the prices of Australian and dairy beef prices. It seems the news of the FMD outbreak, though it may not affect consumers' well-being directly, it affects consumers' perception of quality. Piggott and Marsh (2004) and other researchers have also maintained in their works that the news of an outbreak has an inverse relationship with quality.

Australian beef prices took the largest hit with the FMD outbreak. Figure 1 shows pre-shock estimates for Australian beef prices (the dashed line) with projections associated with the FMD shock. It is estimated that they dropped 12% due to the outbreak by May and they were 13% lower by July. They were still 7% below in December. In contrast, the largest negative impact on wagyu prices was only 6% and that occurred in November, and Japanese dairy beef prices were generally 4% to 6% lower due to the outbreak until December when they rebounded sharply. U.S. beef prices were the only ones that increased for some months with the FMD outbreak. On average, the outbreak had little impact on U.S. beef prices. These results indicate some sophistication among Japanese beef consumers as they reacted less negatively against U.S. beef imports, which were mostly frozen, or against fish and poultry. The FMD results show that, except for the U.S. beef prices, it took several months after the incident for the actual beef prices to begin to recover, but they were still lower than before the outbreak after twelve months. The quantity changes from FMD were less dramatic than price changes and there was also less consistency in the direction of impacts among the meats.

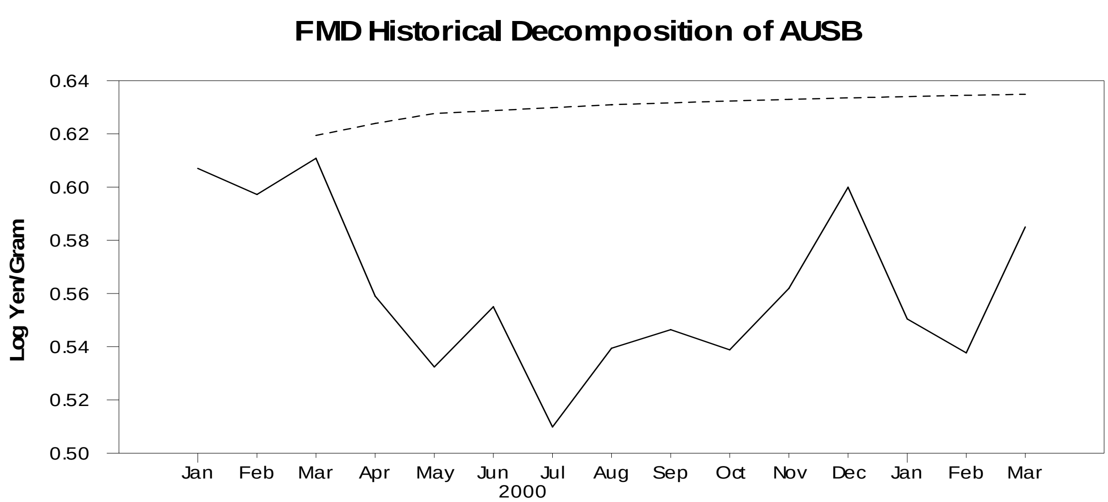

Figure 1: The FMD impact on the Australian beef prices (Yen/Gram in log-form).[5]

[5] The solid line is the actual price including the impact of food scare and the dashed line is its forecast without any shock.

The BSE Impact

The response of domestically produced beef prices in Japan after the BSE shock contrasts with the pattern for imported beef prices in the early months. Imported beef prices in Japan fell immediately in response to the BSE discovery, but domestic beef prices actually increased. Eventually, though, all beef prices were adversely impacted by the BSE discovery. Immediately after the BSE discovery, U.S. beef import prices fell the most dramatically and saw the widest difference between the actual and forecasted prices. U.S. beef prices rebounded after the first two months, but they took another quick dive after December, reaching their lowest point in May, approximately seven months after the outbreak.

Australian beef prices followed a similar pattern to U.S. prices except there was no dramatic drop during the first month. Japanese wagyu and dairy beef prices, on the other hand, rose after the BSE outbreak; certainly not what one would expect. For the most part, however, they remained rather close to what was projected before the outbreak. Yet by December, those prices began to fall absolutely and relative to what they would have been without an outbreak. The pattern for these beef prices may be explained by the way Japanese authorities handled the news of the BSE discovery. The immediate negative responses observed for the U.S beef prices may be attributed to the widely published remarks of a Japanese meat company which stated that imported beef was the most likely source of BSE in Japan, as explained by McCluskey, et al. (2004). After a two-week delay in publicly announcing the first confirmed case, the government's assurances of healthy domestic animals were contradicted by a second case a month later, prompting anxiety among consumers leading to further decline of beef prices.

The results show that the negative effects of the first BSE shock on beef prices were dissipating after a few months, but the second wave of the scare had a stronger impact on beef prices. Mazzocchi (2005) found similar results regarding two instances of BSE crises in Italy. Our results show that while there was concern about all beef in Japan, Japanese domestic beef prices fell less than imported prices, which suggests that Japanese consumers still had more confidence in domestic beef production, despite the BSE outbreaks. Yet after twelve months, consumption of all types of beef was markedly lower than the predictions without a BSE incident. Fish prices fell, surprisingly, right after the BSE outbreak, but were consistently above their original forecasts from December through April. Fish price increases indicate that Japanese consumers might have switched to their traditional diet, fish, because of the BSE scare. This result contrasts with those of Peterson and Chen (2005) who argued that with the BSE scare, demands for non-beef meats were little affected.

Consumption changes were drastic for all meats in the short-run. Purchases of US beef, wagyu beef, and dairy beef fell sharply in October and November, immediately after the BSE outbreak (figure 2).

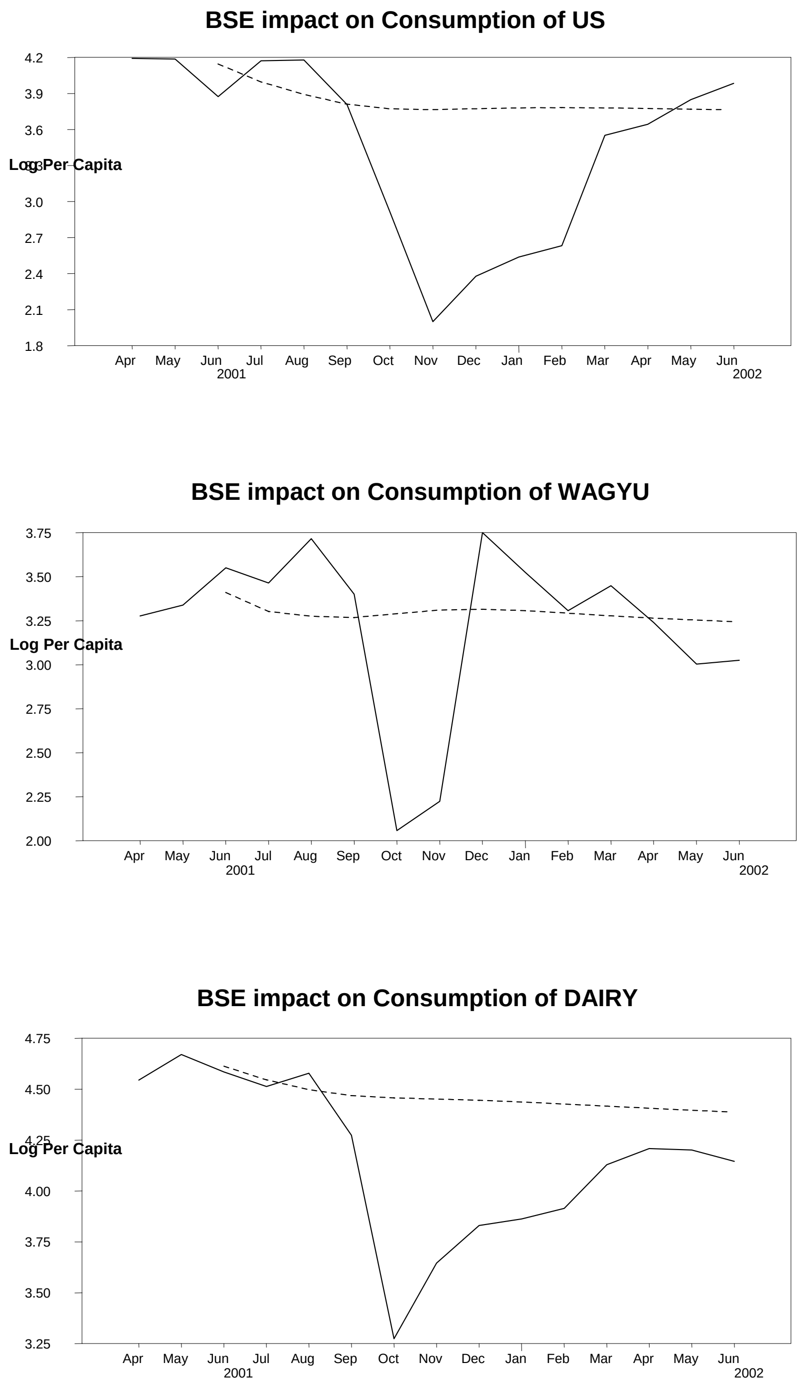

Figure 2: The BSE impact on per capita consumption of U.S., wagyu, and dairy beef (in log-form).

In contrast, consumption of grass fed Australian beef, fish, and poultry increased sharply during the same period (figure 3).

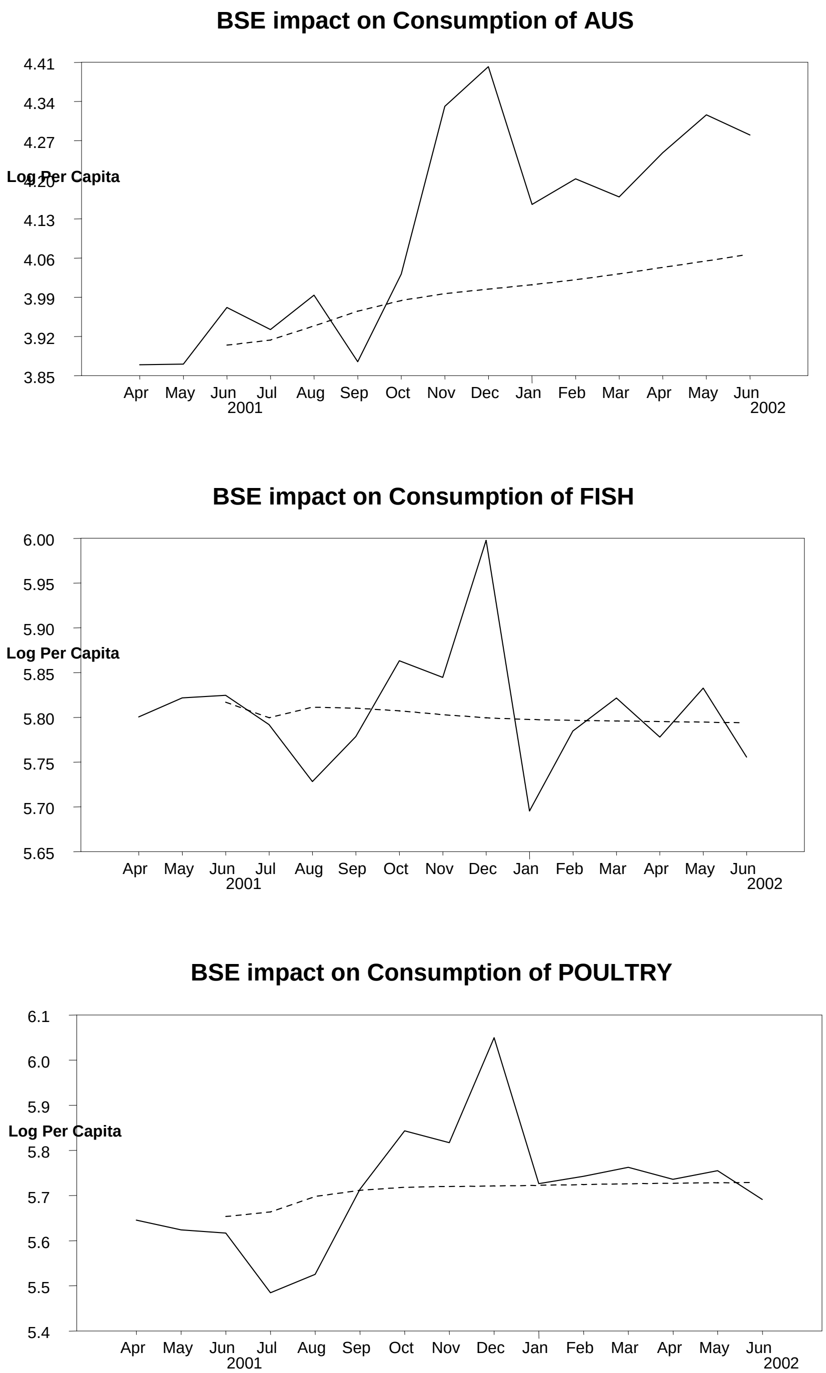

Figure 3: The BSE impact on per capita consumption of fish, poultry, and Australian beef (in log-form).

The impact clearly indicates that consumers were mostly suspicious of the US beef compared to the other beefs. The results show that, contrary to Peterson and Chen (2005) results, consumption of fish and poultry drastically increased. This shows consumers switched to meats considered to be free of a BSE threat. These results indicate that Japanese consumer's purchasing decisions were rational given the kind of information to which they were exposed. While in the short-run consumption of beef decreased, in the longer run, all of the consumption levels were close to the predictions without a BSE incident; but prices, and consequently profit margins, were lower. Consistent with discussions made by Mazzocchi (2005), these results showed that Japanese consumers, as part of a dynamic process, first reacted negatively to the news of beef safety scares and changed their buying and consumption habits accordingly, and over time, as the concerns dissipated and beef safety worries diminished, they reverted back to their previous consumption pattern.

These insights into the habits of consumers and the changing purchasing patterns for consumers of meat products faced with food safety concerns have strategic implications and can help supply chain managers and practitioners in the food industry to understand and develop appropriate strategic responses. It is very important for food firms to be active in providing information to consumers because such information is used in purchasing decisions. Yet the information conveyed must be reliable if trust is to be retained between producers and consumers. Baker (1998) shows consumers prefer increased food safety; he lists several private industry, as well as government policy options, such as labeling and increased production standards and regulatory monitoring that can help address those concerns.

Summary and Concluding Remarks

The effects of food safety scares are part of a dynamic process, where consumers change consumption during the scare and often return to their past behavior afterward. The dynamics of consumers' perception of food safety scares are interesting and important to capture because of their strategic implications for the supply chain management. Food safety events are one of the few shocks that can abruptly eliminate an entire nation from export markets. Generally, the consumers over-react initially to the shock with decreased consumption of the suspect food item, but concern gradually dissipates, leading to the establishment of a new equilibrium. A targeted, accurate information campaign, though, might stave off some of the detrimental short-term consumer adjustments. Supply chain mangers should incorporate this information into their decisions and strategies to make the most of a bad situation.

In this study, we employed monthly retail-level per capita consumption and price series of fish, poultry, and four beef types from different origins in a VEC model along with directed acyclic graphs to estimate causal relationships among residuals. The objective was to explore the dynamic responses of consumers, measured by prices and quantities prevailing, to the impact of FMD and BSE beef safety scares

in Japan. Historical decomposition of the endogenous variables showed that Japanese consumers understood the differences and reacted differently to the news of the two beef safety scares. This evidence conflicts with the observation of Paarlberg, Lee, and Seitzinger (2003) that consumers may not understand the difference between the health risks associated with beef safety crises.
Prices of all beef products were lower twelve months after the BSE discovery, a clear indication that the news of the BSE discovery adversely affected consumers' perceptions of beef quality and lowered profit margins. Yet, the price decrease for the two imported beef types were more than the price decrease for the two domestically produced beef categories. This indicates that Japanese consumers have a more positive view of their own beef products and this keeps their domestic beef products from falling in price as much as imported products. These insights have implications for the advertising and promotion by beef exporting countries. Previous studies (e.g., Comeau, et al, 1997) have found that advertising and promotion for imported beef significantly affect Japanese demand for beef.

While for both shocks, supply adjustments seemed to affect prices, consumption changes due to the BSE shocks were drastic for all meats in the short-run. Japanese consumers moved away from beef that uses high levels of concentrated feeds (US beef, wagyu beef, and dairy beef) and flocked toward grass fed Australian beef and fish and poultry. The consumption changes from the FMD outbreak had less magnitude and were basically unaffected for the FMD outbreak.

Comparison between the BSE results and those of Peterson and Chen (2005) is useful because the same data, but completely different methods, were used. Peterson and Chen concluded that large government expenditures were at least modestly effective in minimizing damage to consumer confidence, but they recognized that long-term impacts were potentially substantial. The results are also consistent with Mazzocchi (2005) and provide evidence that depressed beef prices for all four beef types several months after the initial discovery were largely attributable to the second BSE scare. These appear to potentially be long-run type of effects on beef prices.

Judging by the distinctive price and quantity responses to each food safety scare, the results indicated that Japanese consumers paid attention to what was reported regarding the origin and type of contaminated beef products, as well as the source and type of contamination. This has important ramifications for meat companies and should be instrumental in providing reliable, accurate information on a timely basis. Information from producers and the government affect consumer reactions. In the Japanese case, the government and domestic companies gave out misleading information that affected consumption levels more adversely after the second BSE scare.

The results of this research help beef producers and exporters better understand consumer reactions to beef safety scares. These results provide incentives for beef producers and retailers to proactively inform consumers about ongoing beef safety measures, and can potentially provide policy makers a basis for countermeasures and compensations. Beef safety crises have increased overall awareness of potential future safety problems and the need for robust information technologies in the food marketing system. Time and experience provide a metric for consumers to recalibrate their risk perception and require beef producers and marketers to pay greater attention to beef safety issues and employ measures such as traceability and quality assurance schemes to address consumer concerns. Producers need to be prepared for low-probability events that can have large detrimental impacts. Investments that can be made to lower the large losses from an unlikely event seem to be justified. The BSE situation has certainly created opportunities for producers that have traceable production systems and have quality assurance programs that involve branding and labeling.

Proactive information provision in the food marketing systems reduces the impacts of the food scare. Safe food seems to be largely a public good, so industries have an interest to develop protocols together to provide greater safety assurances. A BSE case or salmonella outbreak impacts everyone; one incidence of "bad strawberries" hurts the whole strawberry industry and even related fruits. The U.S. government and the food industry must continue to invest heavily into procedures that will reduce food safety scares in these areas and into information systems that minimize the impacts of food safety shocks (Woods, 2006).

Beef producers and retailers can promote branded beef with emphasis on variety and quality to differentiate themselves from competitors and gain competitive advantage over rivals. Beef quality assurance schemes incorporate proactive measures such as information provision to minimize consumers' perception of risk associated with search, experience, and credence of beef attributes (Fearne, et al., 2001). McCluskey, et al. (2004) provide arguments of the need for monitoring and validation to build credibility among consumers for credence attributes such as labeled BSE testing and traceability throughout the production process. Quality labeling is now more widely applied in Japan to gain consumer confidence than ever before.

In the case of industry-wide beef promotion and quality assurance schemes, the focus is on managing and reducing consumers' perceived risk of the commodity beef. This is to enhance the image of beef and beef products in the eyes of the public and diminish cross-commodity substitution. Marketing beef safety and quality as an attribute and using quality assurance labels on meat products can effectively restore consumer confidence as well as potentially create niche markets to increase both producer and consumer surplus.

Food safety scares are likely to continue shocking commodity prices in the future. Yet it is hoped that more information and tracking systems are developed to reduce the shock effects. Further, the more food producers educate their consumers and differentiate their products, the less likely consumers' reactions will hurt the firms when the shocks occur.

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